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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Ms. Magalie Roman Salas
Office of the Secretary
Federal Communications Commission
445 Twelfth Street, S.W.
12th Street Lobby, TW-A325
Washington, DC 20554

Re: ***Ex Parte* Presentation**
        CC Docket No. 94-102

Dear Ms. Salas:

On June 9, 1999, Leo Fitzsimon, Kari Kurronen, and Maged Malkawi, of Nokia
Inc., met with Ron Netro, Marty Liebman, Mindy Littell of the FCC's Wireless Bureau,
and Charles Iseman, Bruno Pattan, Bob Eckert, Robert Bromery, and Harry Wong of the
FCC's Office of Engineering and Technology. The purpose of the meeting was to
discuss various location methods for GSM providers to comply with the Commission's E-
911 Automatic Location Identification ("ALI") rules. In particular, Nokia provided FCC
staff with information on the Enhanced Observed Time Difference ("E-OTD") location
method. Nokia also urged the Commission to adopt technology-neutral policies and to
approve a variety of location methods. Nokia's presentation is summarized by the
attached slides.

Pursuant to Section 1.1206 of the Commission's Rules, an original and one copy
of this letter and the attachment are being filed with your office. If you should have any
questions or need further information, please do not hesitate to contact me at (202) 887-
5330.

Sincerely,

Leo R. Fitzsimon
Director
Regulatory and Industry Affairs
Nokia Inc.

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List ABCDE

Enclosure (1)

Cc: Ron Netro
        Marty Liebman
        Mindy Littell
        Charles Iseman
        Bruno Pattan
        Bob Eckert
        Robert Bromery
        Harry Wong

Outline

- GSM Location methods alternatives
- E-OTD method
    - How it works - principle
    - How it works - implementation
    - Cost of E-OTD
    - Addressing of situations where E-OTD cannot be used
        - areas without triangulation possibility (3 base stations not available)
        - legacy handsets
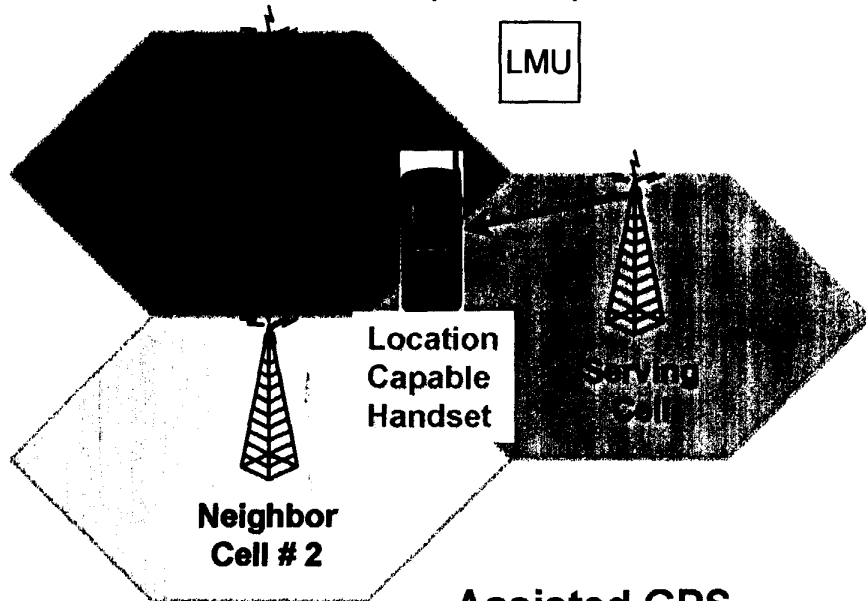   - Addressing roaming subscribers
- Summary

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Location Methods for GSM

9 June 1999

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GSM Location Method Alternatives

Handset Assisted (E-OTD)

LMU

Location
Capable
Handset

Serving
Cell

Neighbor
Cell # 2

Network Based (TOA, AOA)

LMU: Location
Measurement Unit

LMU

Legacy
Handset

Serving
Cell

LMU

Neighbor
Cell # 2

Assisted GPS

Assistance
Data

+ GPS
Receiver
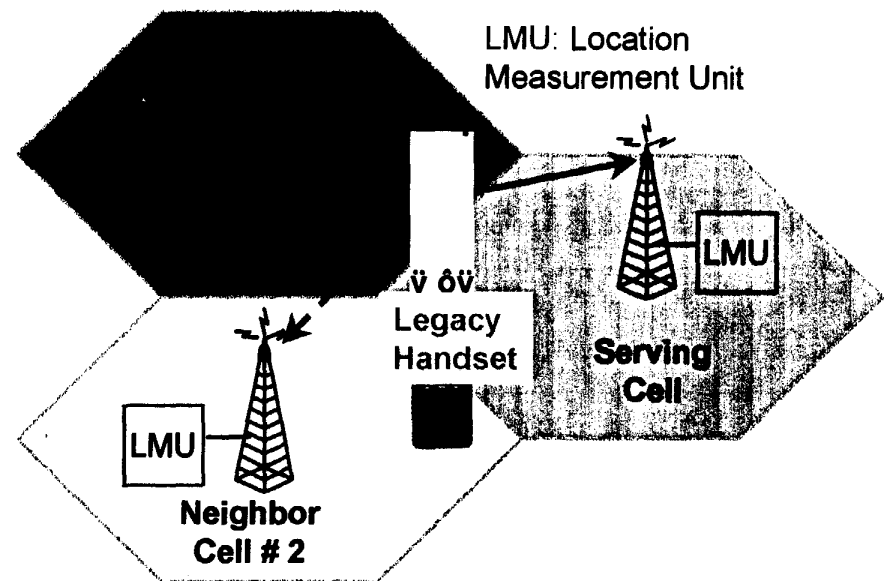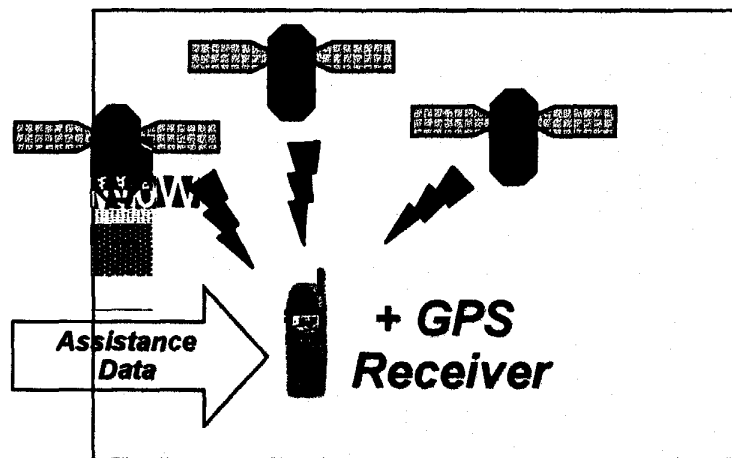
## Cell Identifier+Timing Advance

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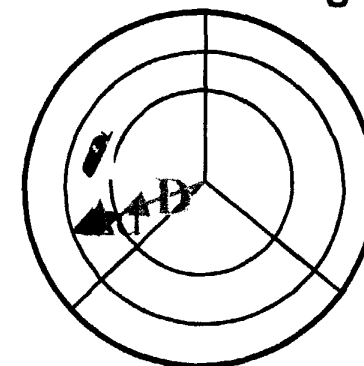
Time Of Arrival (TOA)

- Network based triangulation solution, legacy handsets can be located

- Time Of Arrival (TOA) of signal from the handset is measured at several places in the network. Measurements from at least 3 different cell sites are needed for location calculation.

- Handset position is calculated in network based on the measurements, base station coordinates and network synchronization info.

- TOA requires

  - New receivers (Location Measurement Unit, LMU) to all cell sites

  - Software changes to the Base Station System (BSS) and switch (MSC)

  - Mobile Location Center (MLC) as a separate network element or integrated to existing network elements for location calculation

  - The additional receivers must be synchronized, or the timing differences between the base stations must be known

  - The additional receivers must be ordered to measure simultaneously the handset transmission during intra-cell handover

BTS

BTS

BTS

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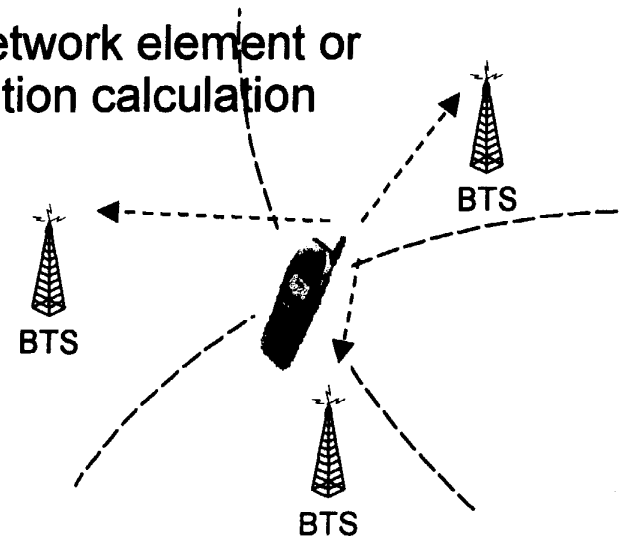
GPS Location Method

- GPS receiver integrated into handset, legacy handsets cannot be located

- Conventional GPS does not work indoors/urban canyons and it has long satellite acquisition times

- Network assisted GPS solutions are being developed to address the problems of conventional GPS

- Assisted GPS requires

    - GPS satellite coverage

    - Integration of GPS receiver into handsets

    - Sending of assistance data from network (emphemeris data, timing data and location of satellites)

    - Some assisted GPS versions require GPS Location Measurement Units in network

    - Some assisted GPS versions require location calculation in network (MLC)

    - New software and hardware is needed to network and handsets

Assisted GPS

Assistance Data

+ GPS Receiver

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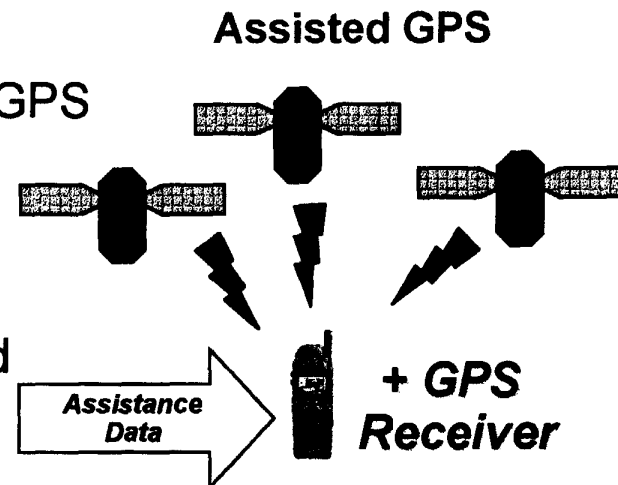
Enhanced Observed Time Difference (E-OTD) Location Method

- E-OTD is a **non-GPS** handset based solution for GSM

- E-OTD requires E-OTD capable handset (but no additional receivers needed to MS), legacy handsets cannot be located

- Handset measures the broadcast signal coming from at least 3 base stations, location is calculated in the network

- Location is calculated based on handset measurements, timing differences between base stations and base station coordinates

- E-OTD requires

  - Low complexity Location Measurement Units (LMU) for every 2-5 cell sites to measure base station timing differences

  - Software changes to the Base Station System (BSS) and switch (MSC)

  - E-OTD software to handsets

  - Mobile Location Center (MLC) as a separate network element or integrated to existing network elements for location calculation
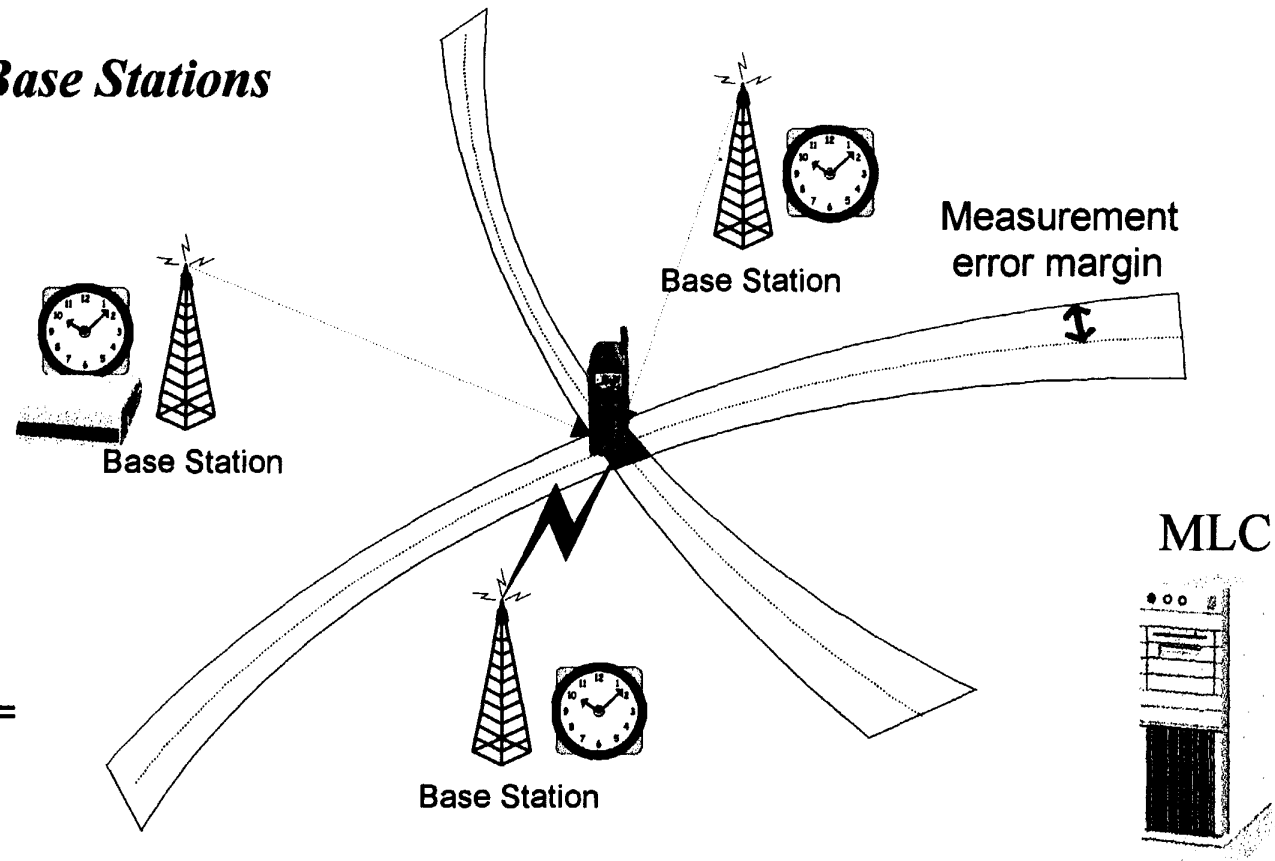
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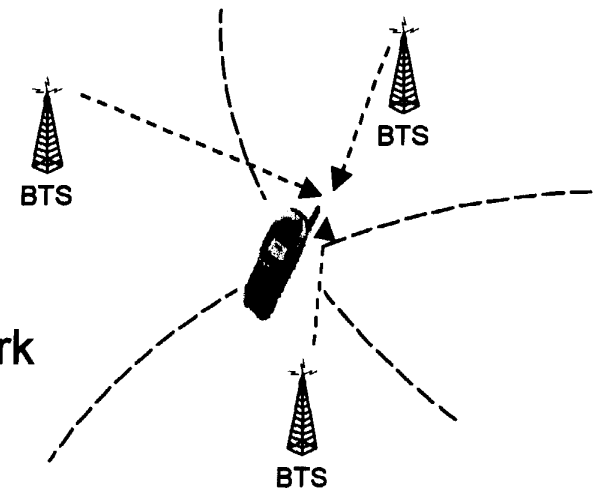
Enhanced Observed Time Difference (E-OTD)

Unsynchronized Base Stations

- MS measures the OTDs of at least three base stations

- The base stations' timing differences in the air i/f (RTDs) are measured

- Location estimate is based on Geometric Time Differences (GTD = OTD - RTD)

Base Station

Base Station

Base Station

Measurement error margin

MLC

Location Measurement Unit (LMU) measures BSs signals and keeps track of BSs clocks

Real Time Difference (RTD) is relative synchronization difference between BSs

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Cost of E-OTD

- Handset costs
  - E-OTD can be implemented with software => zero incremental cost to handsets

- Network costs
  - E-OTD requires low complexity measurement units to every 2-5 cell sites
  - E-OTD requires a Mobile Location Center (MLC) as a separate network element or integrated to existing network elements for location calculation

- Installation costs
  - reduced by equipment size and site requirements

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Addressing Situations Where E-OTD Cannot Be Used

- E-OTD does not work for legacy handsets and in areas where there are not 3 base stations available for E-OTD triangulation => there is a need to have a backup mechanism

- In GSM it is possible to use the information inside the GSM system to improve the location accuracy

  - Cell id (CI) and sector of the serving cell can be mapped to base station coordinates

  - Timing Advance (TA) tells the delay between the handset and the serving base station. TA can be used to estimate the distance of the handset from the base station

  - Cell Id, sector information and TA together can be used to exceed the E911 Phase 1 location accuracy requirement in situations where E-OTD cannot be used

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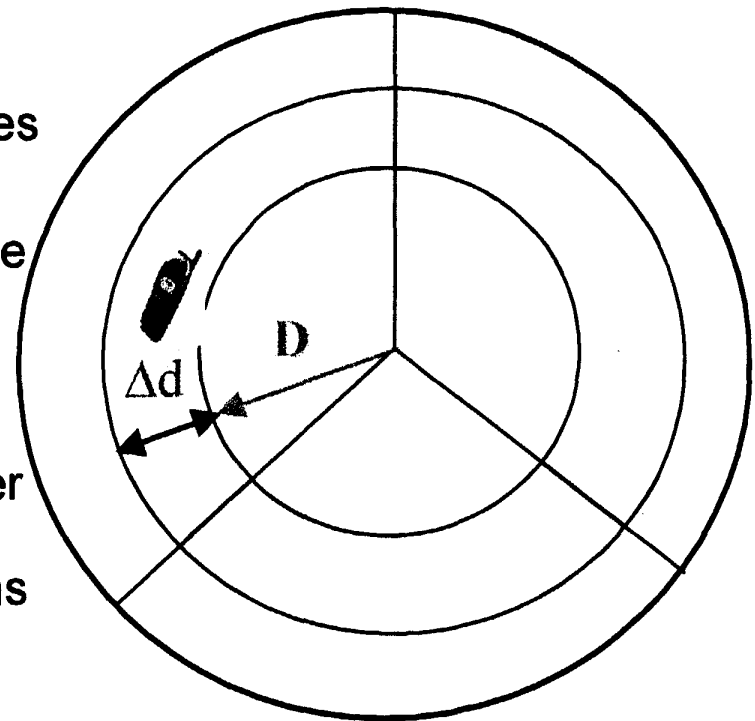
Addressing Roaming Subscribers

- The incremental cost of E-OTD is zero and thus an inexpensive handset implementation is possible

  - inexpensive handset implementation enables a fast introduction of E-OTD to all GSM1900 handset models

  - handsets of roamers will also support E-OTD in the future

- Cell Id, sector information and TA together can be used to exceed the E911 Phase 1 location accuracy requirement if the handsets of roamers do not have the E-OTD capability

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Summary

- Good location system is a combination of several methods

    - Different operators should be able to use different methods

    - One operator can use different methods in different situations (e.g. use cell identifier + TA in the situations where E-OTD does not work)

- Nokia thinks that handset based methods should be allowed for E911 Phase 2

    - GSM has a low-cost **non-GPS** handset assisted method (E-OTD); zero incremental handset cost, low complexity network equipment

- E-OTD handsets will be available before the E911 Phase 2 deadline

- In GSM roaming subscribers & legacy handsets can be handled

    - by allowing methods that enable inexpensive handset implementation (E-OTD)

    - by using information available in GSM system (e.g. cellId + TA) to exceed the accuracy of E911 Phase 1 requirement

- Low cost location system, like E-OTD, is beneficial to consumers & public safety (faster implementation, availability to more consumers)

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